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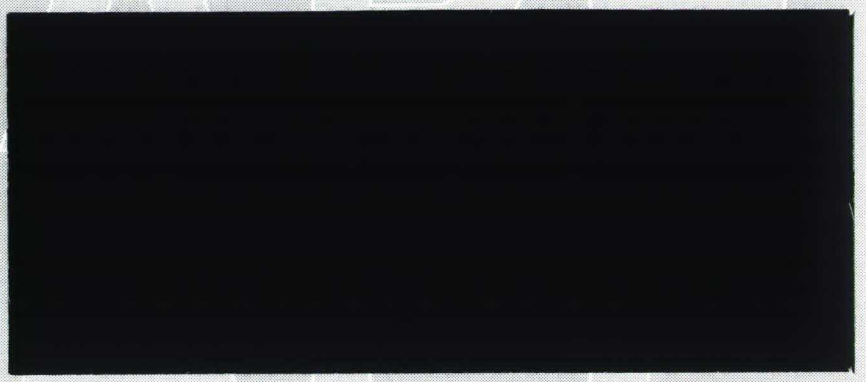

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PAPER

Automatization, Contents of a Job and Operator's Well-Being

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Automatization, contents of job and operator's well-being

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A transition from routine operations (e.c. monitoring and control) to more creative functions as decision making and management is a main feature of changes in operator's job in modern technological system. As our experimental data suggest the effects of such innovation on the base of "total" computerization are rather ambivalent. In parallel with increasing of work productivity and job satisfaction it leads to the symptoms of social dysadaptation, additional mental exhaustion and boarder neurotic states. The patterns of such stress related reactions differ from a fatigue-boredom syndrome, more typical for traditional types of operator's job. A comparison of work settings could help us to understand the nature of stressors, provided these differences.

Introduction

An expansive development of information technologies changes a world of professional life. Many aspects of work environment are radically transformed under influences of computerization (Salvendy et al., 1987; Frese, 1989). Changes in structure of job, mentalization of work, reducing of physical components of job vs. increasing of cognitive loads, alterations in social context are considered as main factors of such transformations (Blackler, 1984; Cooper & Payne, 1988; Roe & Meijer, 1990). These factors correspond to potential sources of stress in new occupations as well as in modernized (or automatized) work settings (Salvendy et al., 1987; Johanssen & Gardell, 1988; Karasek & Theorell, 1990). Accordingly to that a problem of relationships between objective changes in work and dynamics in job efficiency, human well-being and health has a special interest.

It is a question for empirical and experimental investigations to examine a nature of such relations and to clarify a type of their reasoning. In our research we try to study how complex manifestations of human well-being are influenced by the changes in job contents during different stages of automatization of operator's work.

A context of operator's job

Effects of automatization on job efficiency and human well-being were investigated in a longitudinal study on operator's work in a complex computerized system, which provided a technical support for a space tele-communication net. It was a part of a state research programme "Human Factors in Complex Specialized Systems: Elaboration of Psychological Means for Evaluation and Correction of Work Ability and Human Functional States", carried out in collaboration with Space Research Centre from 1985 till 1991 years.
A fragment of our study, presented in the paper, concerns an analysis of dynamics in job

contents and related characteristics of personnel's attitudes to a work situation, subjective well-being and physical/mental health at a special professional group of operators-managers. These specialists are responsible for a functioning of distanced technical means (satellites, etc), named as "dynamic objects", and provide a reliable work in a whole tele-communication system.

A mentioned professional group has a central position in a structure of appropriate technical services - a computerized control system (CCS). Limited in a size, it consists of high-educated professionals with a prolonged work experience in the field (not less than 5 years). An execution of their daily work is supported by lower levels of the same CCS and by extended amount of auxiliary staffs (engineers, programmers, technical assistants). In the Central Technical Service of Moscow Region , where our studies was carried out, there were not more than 50 acting operators at each stage of investigations, and a number of associated specialists were more in 3,5 - 4 times.

Main goals of the operator's work consists in a current functional control of dynamic objects, qualifications of observed defects or deflections and making a prognosis of its reliability. Control procedures with each dynamic object are accomplished separately and correspond to a single working cycle in the operator's job. A prolongation of one working cycle varies from several minutes till half an hour and depends on a complexity of a managed dynamic object. During a shift operators process a succession of working cycles (sometimes till 30 -35) with pauses for a rest. A time schedule of working cycles is strictly ordered by technical reasons. A total amount of working cycles is relevant to a number of different job tasks, performed by an operator per shift.

A professional position of operators-managers is prestige in the organizational hierarchy of CCS and relatively high materially remunerated. But their work is overloaded by influences of various stress factors - such as an abnormal duration of shift, time pressure,

processing of a huge amount of heterogenous information, a dominance of cognitive and sensory-motor modes of performance, a high level of personal responsibility for results of work. It provokes serious problems with operator's well-being, a lowered level of work-ability and increasing of sick-rate, mainly from the side of stress-related symptoms and disorders. In these circumstances systematic medical and psychological observations became to be a necessary element in operator's job environment.

The described professional group is rather unique and scanty. But from the contextual point of view it belongs to a classical type of operator's jobs. In so far as a real dynamic object is absolutely unattainable, an operator can work only with its functional model, which is presented by the means of CCS. Therefore the ways of interactions between operators and a managed dynamic object as well as concrete sets of proceeding procedures are determined by a type of data representations in the functional model and available computerized tools for realizing control actions. These technical/ or technological facilities correspond to a level of automatization of the CCS in the whole.

Stages of automatization

In our longitudinal study we had an occasion to observe impacts of different levels of automatization on operator's performance and dynamics of their psychophysiological states. At the middle of that period (in 1987-1988) it took place a cardinal modernization of computerized working places, first of all concerned with an implementation of more efficient program tools and fitting technical devices.

It produced serious changes in contents of the operator's job. In general, they replicate with a principal transformation in operator's functions from a supplementation of deficient facilities in computerized tools to a real management of dynamic objects. There can be

distinguished three different stages in the process of automatization.

Before a modernization a functional model of a dynamic object consisted of raw data about its current technical parameters and characteristics (sometimes more than 200-250 indexes). It was a due of operators to screen them in a purpose to search any defect or potential hazards, to summarize information and to transfer findings to top and low levels of the whole CCS (see fig.1). It has to be mentioned that in this case computerized tools could provide only a part of operator's actions (screening and detection). The others functions are realized by differ ways, e.g., by verbal or written forms of communications. In such structure an operator is placed in an intermediate position between automatized and non-automatized components of the CCS. So such work setting could be qualified as partially or semi-automatized.

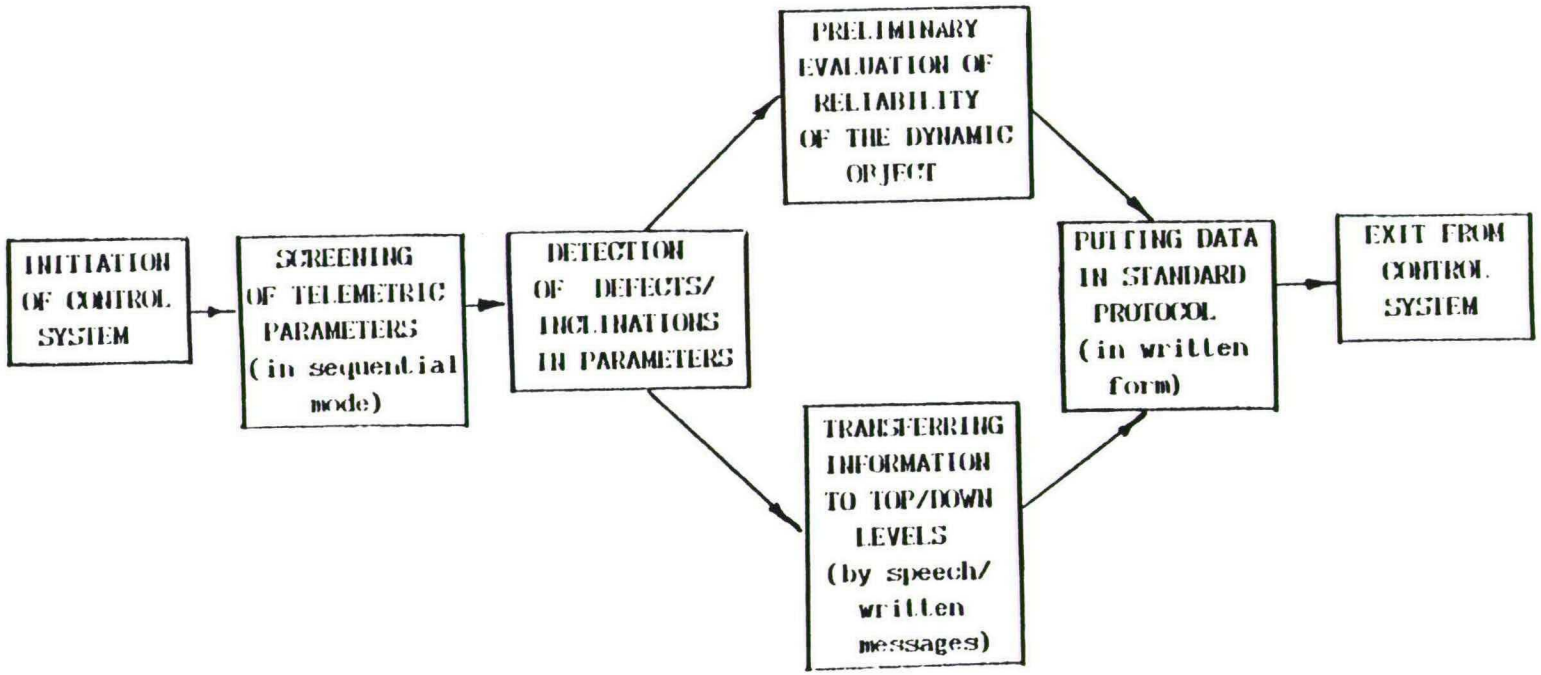

Fig. 1. A general algorithm of performing a single job task (one working cycle) in operator's work before automatization

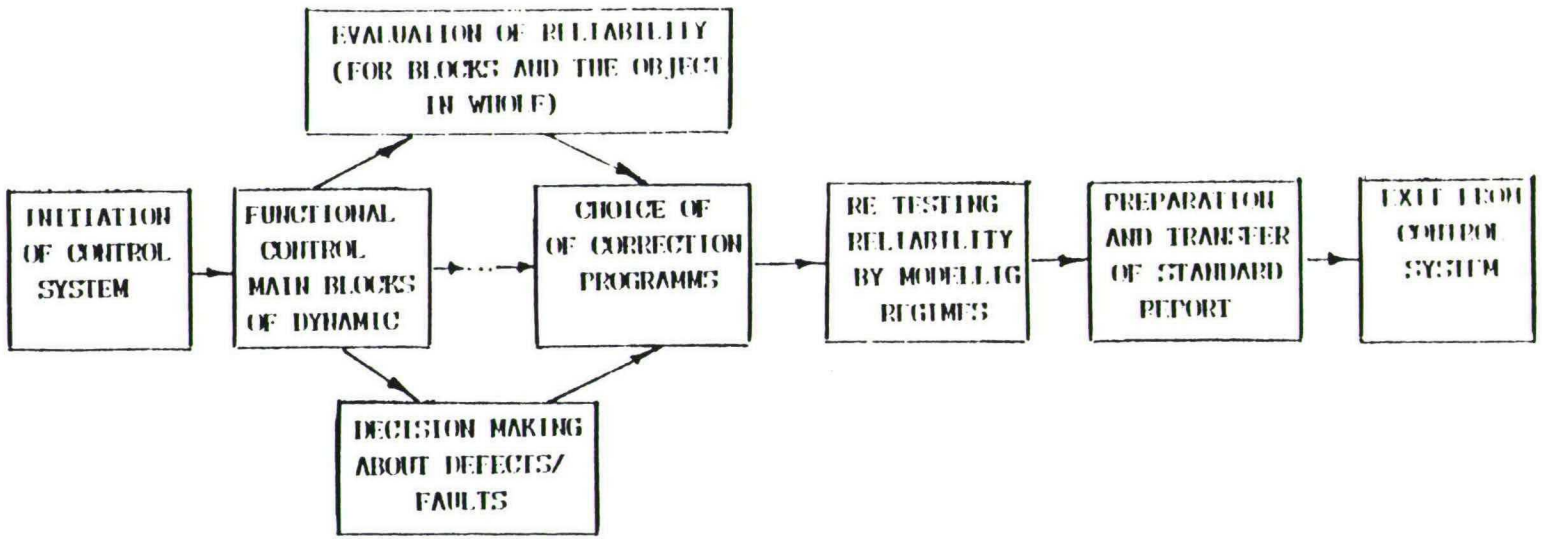

Fig. 2. A general algorithm of performing a single job task (one working cycle) in operator's work after automatization

After modernization computerized tools supplied a more complex representation of the functional model. All kinds of routine operations with single technical parameters are executed automatically. An operator has to work only with pattern's representations of large-scale technological blocks of the dynamic object and then to test its/their reliability by different modelling regimes. Such functional way of realizing control functions extends an area of operator's job goals to making a prognosis on functional capacities of a dynamic object and choosing correction procedures (see fig.2). In addition, main communications in the CCS hierarchy were computerized too. In this case an operator is put above technological processes and realizes functions of supervision, strategic planning, decision making, etc. This work situation is more or less definitely coincide to a notion of automatization.

It is obvious that an installation of a modern technology take a time. Besides of adjustments in a technical part, a problem of a personnel adaptation to a new work setting - re-training, skill acquisitions, fitting to changed work conditions - becomes to be very important. Usually for a normal adaptation and achievement of a stable level of performance it is necessary not less than 0,5 - 1 year. It seems that characteristics of job performance and well-being of personnel at this transitional stage have to be taken in consideration for a more definite evaluation of effects of automatization.

Organization of research

Changes in a complex of operator's characteristics at the different stages of automatization were investigated in the experimental part of our study. In the whole there were selected 3 sets of results, accordingly to critical periods of modernization:

1) before automatization (9 - 12 months before automatization);

2) just after automatization (6 - 8 months later of installation of new techniques);

3) with a delay after automatization (18 - 20 months later of modernization).

These periods were considered as 3 levels of the main independent variable - stages of automatization. Below they are named as **"before"**, **"after 1"** and **"after 2"** conditions.

The results were picked up for a fixed group of operators. They were employed at the same working places during the whole period of investigations (31 male persons, age 28 - 49 years old, professionally employed from 6 till 19 years).

As dependent variables various characteristics of job performance, job satisfaction and operator's well-being were used. They were collected by a set of different observational procedures, expert's evaluations and psychodiagnostic tests. A list of selected measures with a description of used indicators and methods is presented in the table 1. In total for each operator there were proceeded 20 different indicators for each stage of automatization.

Five general groups of measured indicators were analyzed.

Characteristics of job performance were represented by parameters of work outputs:

- a **speed** of processing for one working cycle;
- a **number** executed job tasks per shift;
- an average amount of operator's **errors and defaults** per month.

Job satisfaction was evaluated subjectively and, besides of a **general index**, attached estimations of following components:

- **material prosperity** and incomes;
- **job content**;
- **work conditions**;

- perspectives of **career development**;
- **personal interests**, attitudes and self-realization.

Operator's well-being was considered widely and involved three levels of evaluations:

1) Subjective feelings of current psychological state:
   - actual **well-being**;
   - **emotional strain** by index of state anxiety;
   - symptoms of **acute fatigue**;
   - subjective feelings of **monotony**.

2) Subjective manifestations of negative chronic states:
   - **prolonged stress reactions**,
   - **chronic fatigue** or asthenia,
   - **trait anxiety**.

3) Psychosomatic symptomology and disorders:
   - negative **heart-vascular symptoms**;
   - **gastric disorders**,
   - **hormonal disfunctions**;
   - symptoms of **depression** and **neurotic reactions**.

   (These data were collected on the base of medical expertise).

An analysis of data pursued two purpose. First of all, a discovering of main tendencies in dynamics of measured indicators under influences of stages of automatization had a principal interest. A significance of trends in each indicator was defined by Analysis of Variance (one-factor model, 3 levels of the factor "stage of automatization", $n = 31$). Then a comparison within and between groups of indicators were made.

Secondly, a type of relations between parameters of job performance and different aspects of operator's well-being were considered. For a preliminary discussion of this problem a factorization of the data sets for each experimental condition was done. Factor structures at different stages of automatization were compared in the purpose to analyze a type of their transformation.

Effects of automatization on parameters of job performance and operator's well-being

An influence of changes in the operator's job after automatization is pronounced for a majority of measured indicators. It concerns both to objective parameters of work outputs and different characteristics of well-being. The data about significant trends, their directions and possible interpretations are summarized in the table 2 (for more detailed statistical results see Appendix A). The types of observed tendencies in different groups of characteristics are not the same and often look as contradictory. For a clarification of such complex picture we have to consider the effects in each group of measured characteristics.

A. Work outcomes and efficiency of job

All parameters of job performance are significantly improved after modernization of working places. Temporal expenses for one working cycle reduce in 1.4 - 1.6 times. It provides an appropriate increase of a number of job tasks, performed by operators per shift. A quality of performance is not suffered from such intensification - a number of operator's errors is even decreased. These effects appear just after automatization (condition "after 1") and stabilize to the end of adaptation processes (condition "after 2").

B. Job satisfaction

A general index of job satisfaction increases after automatization, especially at the initial stage (condition "after 1"). But not all components of a subjective job's attractiveness change in this way. Mainly, a pronounced improvement of personnel's satisfaction concerns contextual characteristics of labour - an enrichment of job contents and work conditions, accompanied with a growth of professional interests and possibilities for an intellectual self-realization. Two "external" parameters - material prosperity and, in slight degree, perspectives for career development - significantly decrease during successive stages of automatization. However, it cannot be connected only with the changes in job structure but mostly with influences of extraordinary social transformations - periods of modernization have coincided with the "perestroika" time.

C. Influences on current and chronic states

Different aspects of subjective experiences, accordingly to both current and chronic components of a psychological state, are affected by changes in work environment.

There are observed some positive changes in manifestations of current states after automatization - reduced feelings of monotony and a slight improvement of general well-being, mostly for symptoms of behavioral activation. A stable level of acute fatigue in all experimental conditions (in spite of an objective increase of mental loads) attaches the same class of events.

An expressed growing of emotional strain in both "after automatization" conditions is in serious contradictions with such positive trends. A stable rise of reactive anxiety from medium (condition "before") till high (conditions "after 1" and "after 2) levels reveals an overloading in emotional regulatory mechanisms of activity.

Intensive feelings of a current emotion strain are related with increasing manifestations of negative chronic states. At the first turn it concerns with strengthening symptoms of prolonged stress reactions and an appropriate elevation of trait anxiety. At the condition "after 2" an average level of trait anxiety moves to a range of high values. In parallel a gradual cumulation of asthenic symptoms takes place. A level of chronic fatigue begins to exceed a moderate degree in the last experimental condition ("after 2"). Such trends can be interpreted as a sign of a development of frontier states and psychosomatic syndromes.

D. Dynamics of psychosomatic symptomology

Even background data about operator's health (condition "before") seem to be inauspicious. Four groups of negative syndromes, related to psychosomatic reactions and disorders, are depicted in medical protocols and observations. More then a half of observed operators have complaints and objective deflexion from a norm in the respects of a) functions of cardia-vascular system (26.2%); b) gastro-intestinal digestion (14.6%); c) hormonal regulations, mainly in direction of glycogen-storage diseases (6.7%); d) an appearance of depressive and neurotic reactions (10.3%). A frequency of their manifestations correlates with a duration of professional job ($r=0.407$, $n=31$, $p < 0,05$), and so can be considered as an internal price for a prolonged work in a stressful work environment.

After automatization an amount of subjective complaints and psychosomatic symptoms increases, especially from the side of cardia-vascular deteriorations. Also a slight increase of negative symptoms in mental health (sleeplessness, aggressive reactions, communicative difficulties) and gastric disorders are observed. A number of hormonal disfunctions does not change significantly.

An expressed ascent of psychosomatic symptoms appears just after automatization (condition "after 1") and, in spite of a small reduction, remains on a high level at following

stage (condition "after 2"). It suggests that an increase of psychosomatic symptomology is not only a transient response to a period of acute adaptation and has a tendency to a consolidation. An accumulation of prolonged stress experience in new work environment could be referred to this trend.

Relationships between parameters of job performance and operator's well-being

Patterns of relationships between measured characteristics were obtained on the base of Factor Analysis. For this purpose estimations of each parameters and indicators have been transformed to a comparable 5-point scale, where the minimum score 1 corresponds to the poorest degree for each indicator and, appropriately, maximum score 5 - to the best ones. It was done by procedures of expert's evaluations.

Lists of factors ("factor structures") for each experimental conditions are presented in Appendix B, tables A, B and C. A discussion of the data has a preliminary character - we try only to select main agglomerations of job characteristics and manifestations of well-being, typical for each stage of automatization, and then to notice a type of their transformation from one stage to another.

Before a complete automatization a factor structure includes 5 clear separated factors. A more capacious of them (factor 1) includes subjective attitudes to a job contents and work conditions with a majority of parameters of chronic states, current well-being and negative cardia-vascular symptoms. It can be interpreted as a **subjective attractiveness-difficulty of current job situation**. At the factor 2 there are united external estimations of **job satisfaction**, related to a level of acute fatigue. The factor 3 includes all parameters of **work outcomes**, correlated with a level of emotional strain. In the factors 4 and 5 there are separated symptoms of **hormonal** and **gastric** disorders with joint manifestations of current and chronic states.

Just after automatization a factor structure begin to be more diffuse. It consists of 8 factors. Three of them remain the same as in the previous case: external **job satisfaction** (factor 1), **gastric** (factor 6) and **hormonal** (factor 7) disorders with more or less identical sets of state's manifestations.

The other factors demonstrate a disintegration in an initially closed block of parameters of work outcomes. Each parameter of job performance seems to be more independent and correlates with different aspects of well-being: a frequency of **errors** with actual well-being and chronic fatigue (factor 2); a **speed** of performance with current emotional strain (factor 3); a **number of performed tasks** with negative cardia-vascular symptoms and a satisfaction with job contents (factor 4).

Two factors indicate relationships between satisfaction with new **work conditions**, trait anxiety and depressive symptoms (factor 5) and contradictory relations between feelings of **monotony and acute fatigue** (factor 8).

1,5 year after automatization a factor structure again comes to be more definite. It consists of 6 factors. Three of them are equivalent to the stable factors in previous cases - external **job satisfaction** with related feelings of fatigue (factor 1); **gastric** disorders with manifestations of depression and monotony (factor 5); **hormonal** disfunctions with prolonged stress reactions and asthenic symptoms (factor 6).
The other three are connected with different aspects of work outputs and associated manifestations of states. There are observed a consolidation of earlier appeared tendencies. An amount of **errors** relates to actual well-being, chronic fatigue and, in additional, monotony (factor 2). A **number of job tasks**, as well as attractiveness of job contents, has negative links with a level of trait anxiety and cardia-vascular symptoms (factor 3). A **speed** of performance correlates closely with an increasing of a current emotional strain (factor 4).

A comparison between different factor structures demonstrates that automatization leads to re-organization in patterns of links between different characteristics of job performance and well-being. A main tendency consists in a separation of the different aspects of work outputs, accordingly to a differentiation of their relationships with definite components of well-being and subjective attitudes to a job (see fig. 3). Besides of a presence of several constant factors at all stages, there are observed a divergence in an initially blended group of work outputs after automatization.

Such splitting illustrates a stipulation of each work output's parameter by certain subjective feelings and attributes. A high **speed** of performance is closely related with an increase in a current level of **emotional tension**. A growth of productivity (a **number of performed tasks**) is more associated with an increasing level of **trait anxiety** and a development of **cardia-vascular** disorders. A quality of work (a reduction of **errors**) is connected with an improvement in subjective feelings of **actual well-being**, **monotony** and with a reduced level of **chronic fatigue**.

These tendencies emerge just after automatization (condition "after 1") and are displayed more clear after the end of the period of adaptation (condition "after 2"). So they could be corresponded to an increasing of a contextual job complexity due to automatization. A constancy of some factors in factor structures is probably related to some common features of an operator's work environment, independently of the stages of automatization.

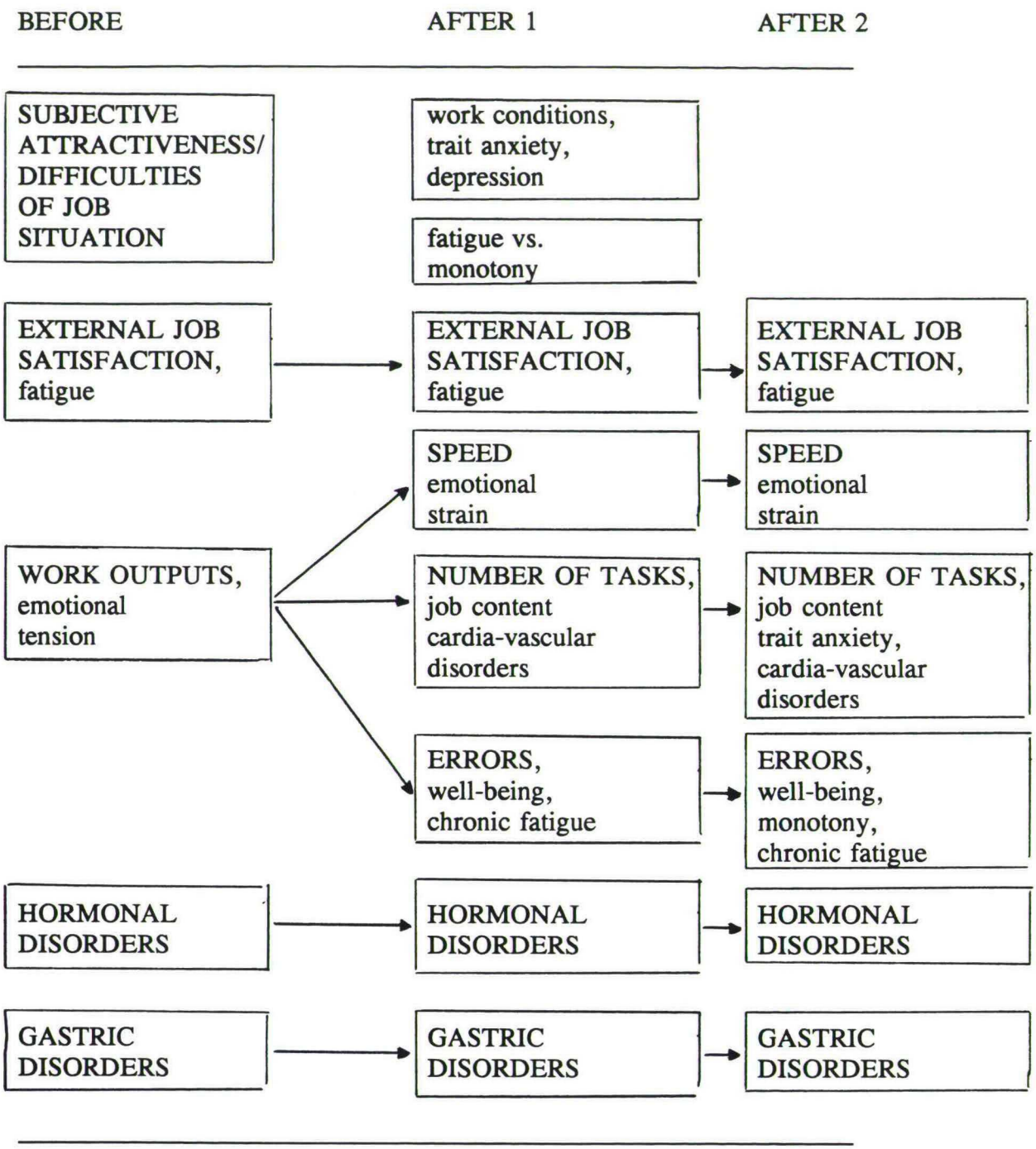

Fig. 3 Transformations in factor structures of indicators at different stages of automatization

Discussion

As it was mentioned above, a modernization of operator's working place has produced a cardinal change in the considered type of job. From the work in a semi-automatized system, where the functions of technical assistance and communications were dominant, the operators moved to an almost completely computerized work environment. Here they got functions of a real supervision and management. Such development provides an obvious enrichment of job contents, relieves an execution of routine operations, removes a superfluous heterogeneity of work loads, regulates a structure of job performance. On the other hand, it leads to a growing of mental loads, especially in their complex cognitive components, enhances a work schedule, deprives personal contacts, increases an individual responsibility for any action. It seems that an ambivalence of these influences defines an intricacy of received results.

We would not like to give a simplified interpretation of obtained data in terms of an ordinary intensification of an operator's work. The facts of an expressed increase of work outputs, accompanied with significant deteriorations in chronic aspects of psychological states and an accumulation of psychosomatic symptoms, could support such opinion. But in the whole a described picture of changes does not look as a simple exhaustion of individual resources.

Many aspects of subjective perception and attitudes to a new work situation, as well as some components of current states, improve clearly after automatization. In general, job satisfaction and subjective attractiveness of work are growing after automatization. Exceptions concern only the parameters of material prosperity and clearness of career perspectives. But the last ones are more probably related to extraordinary changes in a global social environment than with changes in a job contents. In parallel with increasing of an "internal" job satisfaction several indicators of current well-being are not deprived

and even improve (e.g., feelings of monotony, acute fatigue). Only an increased and high level of current emotional strain relates directly to the negative effects of automatization from the point of view of actual subjective experience.

A rise of emotional strain seems to have a most important value in regulations of an operator's activity after automatization. At first, a type of observed disorders in chronic states and psychosomatic symptomology (prolonged stress reactions, a high level of trait anxiety, heart-vascular disfunctions and neurotic reactions) looks as a natural result of constant feelings of emotional stress. Secondly, an increase of emotional strain corresponds with dynamics in parameters of work outputs in all experimental conditions. After automatization it becomes more directly correlated with the speed of performance - a most important parameter in keeping within work regimes. Its derivatives (e.g. trait anxiety, prolonged stress reaction) correlate with the productivity and quality of job performance. So the variable "emotional strain" links together the levels of job demands, a way of their realizing and internal costs of activity.

We suppose that a complete automatization changes a type of actualization of human internal resources, resulted in differences of observed state's syndromes. A work in semi-automatized system produces a more or less typical fatigue-boredom syndrome. It is represented with a complex agglomeration of different subjective feelings in the main factor (factor 1) in the condition "before automatization". A crumbling of this factor and re-distributions of the symptoms among other factors, obtained after automatization, supports this assumption. A splitting in factor structures during the stages of automatization refers to a development of new vectors in dynamics of operator's states. It seems that the main vector can be defined by a strengthening of emotional tension and an appearance of associated stress-related reactions. But a more detailed analysis of observed types of state's syndromes requires specialized psycho-diagnostic tools.

Almost all of mentioned effects appear from the beginning stage of "total" automatization. Some of them are emphasized just after automatization and then go to a more stable level. Dynamics of the others tend to be cumulative. But the main directions of trends are common for both stages after automatization. It means that obtained tendencies are not transient reactions of the adaptation stage. Due to a process of automatization they are determined by profound changes in the contents of job and work environment.

Conclusions

A transition from a routine services operations (like monitoring and transferring of information) to more creative functions (decision making and management) is a main feature of changes in operator's job after a complete automatization. It provides a sufficient improvement in productivity and quality of job performance but has a rather ambivalent influence on different components of operator's well-being. Besides of a positive increase of job satisfaction (mainly from the side of a subjective attractiveness of work) some indicators of a current psychological state are also improved. In the same time, a consolidation of prolonged stress reactions and an appropriate accumulation of psychosomatic symptomology have been observed. An increased level of emotional strain, both from current and chronic points of view, can be mentioned as a main reason of such negative development.

A pattern of mentioned stress-related reactions differs from a fatigue-boredom syndrome, more typical for traditional types of operator's job (Salvendy et al., 1987; Leonova, 1984; Cooper & Payne, 1988). For these circumstances a deficiency in mechanisms of emotional regulations looks as a more adequate explanatory principle than a simple exhaustion of psycho-physiological resources. An elaboration of appropriate analytic models is a point for a discussion and needs in further investigations.

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Table 1. List of measures

Type of measures	Indicators	Measured characteristics and procedures
Work outputs	Speed of job performance	Average temporal expenses for one working cycle (in min), chronometric observations
	Number of performed job tasks	Average number of working cycles per shift, analysis of protocols
	Number of errors	Average number of operator's errors and false decisions per month, analysis of protocols
Job satisfaction	General index Material prosperity Job contents Working conditions Career development Personal interests	Multidimensional checklist for subjective scaling of job satisfaction[1)]
Current psychological state	Well-being	Subjective scale for general well-being[2)]
	Emotional strain	Spilberger's State Anxiety Scale
	Acute fatigue	Checklist for acute fatigue[2)]
	Monotony	Subjective scale for boredom and monotony in job[3)]
Chronic psychological state	Prolonged stress reactions	Checklist for neuro-mental tension[4)]
	Chronic fatigue	Checklist for chronic fatigue[2)]
	Personal anxiety	Spilberger's Trait Anxiety Scale
Psychosomatic symptoms	Heart-vascular disorders	Data of systematic medical observations
	Gastric disorders	" "
	Hormonal disorders	" "
	Depression, neurotic states	" "

1) Fomicheva, 1982; [2)]Leonova et al.,1987; [3)]Fetiskin, 1992; [4)] Nemchin, 1981

Table 2. Effects of automatizations on parameters of job performance, physological states and health of operators (For statistical data see Appendix A)

Indicators	Dimension of changes	Interpretation
Work outputs:		
- speed	increase***	Significant improvement
- number of tasks	increase***	of job performance just
- errors	reduction***	after automatization with a stabilization of positive effects
Job satisfaction:		
- general index	increase**	Increasing in general
- material prosperity	reduction***	level of job satisfaction
- job contents	increase**	mainly by the contextual
- working conditions	increase**	job characteristics, loss
- career development	slight decrease*	in material interests
- personal interests	increase*	
Current state:		
- well-being	slight increase*	Decrement in feelings of
- emotional strain	increase***	subjective monotony with
- acute fatigue	no changes	a strong increase of
- monotony	reduction**	emotional strain
Chronic state:		
- prolonged stress	increase**	Strengthened increase of
- chronic fatigue	slight increase*	chronic stress reactions
- trait anxiety	increase**	with increasing feelings of anxiety
Psychosomatic symptoms:		
- heart-vascular	increase**	Increasing of negative
- gastric	slight increase*	health symptoms, mainly
- hormonal	no changes	from the side of cardia-
- depression, neurotic states	slight increase*	vascular system

A number of marks '*' indicates a level of significant differences: *** - $p < 0.01$; ** - $p < 0.05$; * - $p < 0.1$

Appendix A **Effects of automatization**

Results of Analysis of Variance: independent variable -"Stage of automatization, 3 levels, n = 31 operators

Indicators	Mean scores			F	df	p
	Before	After1	After2			
Work outputs:						
- speed	23.7	15.2	17.4	57.31	2/30	0.01
- number of tasks	16.5	27.6	28.9	101.75	"	0.01
- errors	7.8	5.6	4.1	89.22	"	0.01
Job satisfaction:						
- general index	4.9	5.9	5.7	4.89	"	0.05
- material prosperity	6.0	5.4	4.3	11.37	"	0.01
- job contents	3.8	6.3	6.8	19.51	"	0.01
- working conditions	3.9	5.8	5.6	3.91	"	0.05
- career development	5.9	5.3	5.5	2.33	"	0.1*
- personal interests	5.2	7.1	6.6	4.18	"	0.05
Current state:						
- well-being	45.1	51.3	53.2	2.67	"	0.1*
- emotional strain	42.7	46.8	45.7	7.84	"	0.01
- acute fatigue	21.3	18.9	19.6	1.07	"	-
- monotony	6.1	3.9	4.4	5.19	"	0.05
Chronic states:						
- prolonged stress	48.4	53.6	56.1	4.32	"	0.05
- chronic fatigue	21.3	24.8	27.2	3.07	"	0.1*
- trait anxiety	41.3	43.7	45.3	5.09	"	0.05
Psychosomatic symptoms:						
- heart-vascular	26.2	38.5	33.1	3.78	"	0.05
- gastric	14.6	19.3	18.7	2.61	"	0.1*
- hormonal	6.7	7.1	8.9	1.85	"	-
- depression, neurotic states	10.3	17.7	21.4	2.59	"	0.1*

With the mark "*" there is mentioned only a trend to significant changes ($p < 0.1$).

Appendix 2 **Table A**

Factor structure of indicators for the condition "Before automatization" (20 indicators, n = 31 operators)

General results of Factor Analysis:
5 factors, described 73.4% of total dispersion

Factor 1 (21.7%)	**Factor 2 (19.6%)**
- job contents (0.78)	- general index JS (0.78)
- heart-vascular s.(0.76)	- acute fatigue (0.75)
- trait anxiety (0.72)	- material prosperity (0.69)
- prolonged stress (0.71)	- career development (0.68)
- work conditions (0.68)	- personal interests (0.53)
- well-being (0.54)	
- chronic fatigue (0.53)	
- emotional tension (0.51)	
- monotony (0.50)	
Factor 3 (12.3%)	**Factor 4 (10.5%)**
- number of tasks (0.83)	- gastric s. (0.89)
- speed (0.76)	- monotony (0.58)
- errors (0.63)	- depression (0.52)
- emotional strain (-0.57)	
Factor 5 (9.3%)	
- hormonal s. (0.82)	
- prolonged stress (0.56)	
- chronic fatigue (0.51)	

JS - job satisfaction; s. - symptoms

Appendix 2 **Table B**

Factor structure of indicators for the condition "Just after automatizatoin - after 1" (20 indicators, n = 31 operators)

General results of Factor Analysis:
8 factors, described 79.8% of total dispersion

Factor 1 (17.4%)	**Factor 2 (10.6%)**
- material prosperity (0.86)	- errors (0.83)
- career development (0.83)	- well-being (0.79)
- personal interests (0.80)	- chronic fatigue (0.53)
- general index of JS (0.64)	
- acute fatigue (-0.48)	
Factor 3 (9.5%)	**Factor 4 (9.3%)**
- emotional strain (-0.89)	- number of tasks (0.75)
- speed (0.69)	- job contents (0.67)
	- heart-vascular s. (-0.59)
Factor 5 (9.1%)	**Factor 6 (8.8%)**
- work conditions (0.80)	- gastric s. (0.83)
- trait anxiety (0.52)	- depression (0.69)
- depression (0.49)	- monotony (0.53)
Factor 7 (7.9%)	**Factor 8 (7.3%)**
- hormonal s. (0.81)	- acute fatigue (0.95)
- prolonged stress (0.62)	- monotony (-0.59)

JS - job satisfaction; s. - symptoms

Appendix 2 **Table C**

Factor structure of indicators for the condition "With a delay after automatization - After 2" (20 indicators, n = 31 operators)

General results of Factor Analysis:
6 factors, described 81.2% of total dispersion

Factor 1 (23.3%)	**Factor 2 (15.2%)**
- general index of JS (0.84)	- errors (0.66)
- material prosperity (0.80)	- work conditions (0.61)
- chronic fatigue (0.68)	- well-being (0.60)
- personal interests (0.56)	- prolonged stress (0.53)
- career development (0.54)	- chronic fatigue (0.47)
- acute fatigue (0.52)	
Factor 3 (13.3%)	**Factor 4 (13.2%)**
- trait-anxiety (-0.77)	- speed (0.89)
- number of tasks (0.65)	- emotional strain (-0.66)
- job content (0.51)	
- heart-vascular s. (-0.49)	
Factor 5 (9.0%)	**Factor 6 (7.2%)**
- depression (0.85)	- hormonal s.(0.80)
- gastric s. (0.61)	- chronic fatigue (0.54)
- monotony (0.49)	- prolonged stress (0.51)

JS - job satisfaction; s. - symptoms

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